# 第 XVII 部

# 災害時における情報通信基盤の開発

# 第 17 部
# 災害時における情報通信基盤の開発

## 第 1 章　LifeLine Station (LLS) WG

LifeLine Station (LLS) WG was launched in 2008 aiming for designing and developing an architecture of an information package for post-disaster communications. This is the first report of LLS WG.

The activities conducted in 2009 are:

(1) Concept building of an information package for post-disaster communications,
(2) Design and implementation of the LLS prototype, and
(3) Demonstrations of the prototype.

Each activity will be described in the following sections.

### 1.1 Concept Building

#### 1.1.1 LifeLine Station

For designing an information system, we discussed the disaster situations where the system will be introduced. Then the concept and basic architecture of the system was organized to be deployed as an ICT infrastructure there.

In disaster situations, communication inside and outside the disaster site is important. Expecting victims of a disaster, government staffs or assigned volunteers as users. Namely, the following services will be necessary for rescue, recovery or second disaster prevention:

(1) Audio or video communication,
(2) Safety information,
(3) Hazardous area information,
(4) Emergency radio,
(5) Rescue supply logistics,
(6) Staff and volunteer assignment, and
(7) Telemedicine.

However, if the existing communication infrastructure is damaged, such services may not be available or effective.

For the quick recovery from such a disconnected or restricted situation, we introduce a quickly deployable package for post disaster communications: *LifeLine Station (LLS)*. LLS is a portable package of IP-based communication facility, that can be kept in small packages and mobilized to deploy network in a disaster site to enable:

(1) communication within the disaster site,
(2) Internet access from the disaster site, and
(3) various ICT services for rescue, recovery or second disaster prevention.

Disaster that we expect is an earthquake that may seriously damage the existing facility and infrastructure: power supply, emergency alerting systems, cellular phone, telephony, Internet access, TV and radio broadcasting.

The following concepts are arranged for designing LLS including the network to provide and the system components.

**Self-contained**

LLS provides reachability to the Internet from a disaster site, even if the existing facility or ICT infrastructure may not be available in the disaster site.

**Lightweight and Small**

Two people are enough to carry and settle LLS. Also, because LLS is packed into small portions, each package can be transported, for example, by car.

**Easy and Simple**

The equipment of LLS is pre-configured. Expecting average people as users, the installation procedure is simplified as much as possible. Expert operators will not be mandatory.

**Utilization of available resources**

If power supply, computers or devices are

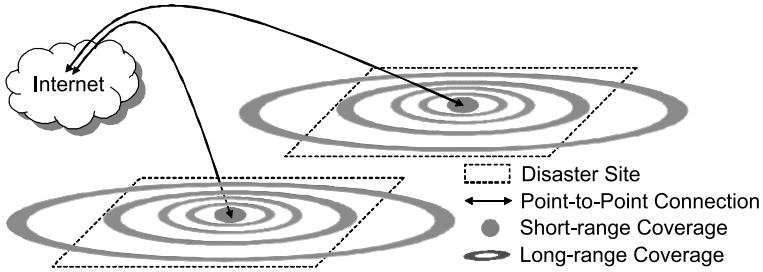



**Fig. 1.1.** Disaster Sites Covered by LLS

**Table 1.1.** LLS Package Classification

| Class | Description |
|---|---|
| 0 | Power Supply |
| 1 | Internet access using satellite communication |
| 2 | WiFi networking |
| 3 | Digital broadcasting |
| 4 | Internet access using wide-area wireless communication |
| 5 | Monitoring and control using sensors, robots or vehicles |

available in the disaster site, they will be the resource that may sustain and enhance services on LLS.

**Flexibility as ICT infrastructure**

LLS enables an ICT infrastructure where various information devices are available in the disaster site.

### 1.1.2 Internet Access in Disaster Site

The network enabled by LLS provides wireless access to the Internet with devices in a disaster site as shown in Figure 1.1.

Basically LLS has one or more point-to-point connectivities to the Internet, and wireless LAN or MAN technologies work to expand the coverage where access to the Internet is available. When there are multiple disaster sites concurrently, they can be interconnected once each acquires connectivity to the Internet.

### 1.1.3 System Overview

Functionality of LLS is classified into 6 classes as shown in Table 1.1. Each class is packed in one or a few transportable portions so that requisite functionalities can be selected and then deployed to work. For example, if the in-house power supply is still operational, Power Supply package may not be required to mobilize.

## 1.2 Prototype Design

Based on the LLS concept, we designed and implemented the prototype of LLS. In this section, the design of the components of LLS are addressed respectively.

### 1.2.1 Class 0: Power Supply Package

Power supply package provides electricity to LLS facilities and devices that will connect to LLS. It is desirable that the power supply is stabilized and sustained as long as possible. As shown in Figure 1.2, this package functions as stabilized power supply. The power input from a power source charges the battery of an uninterruptible power system (UPS). Then the UPS provides the

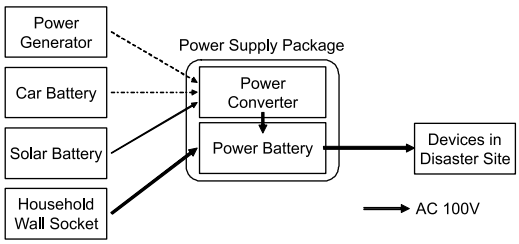



**Fig. 1.2.** Power Supply Package

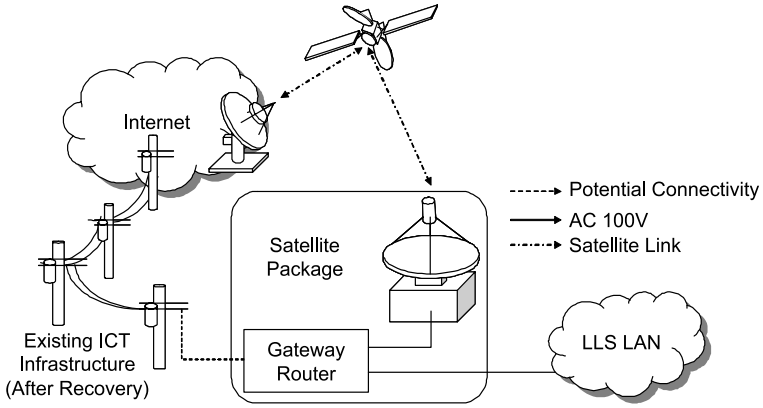



**Fig. 1.3.** Satellite Package

electricity with devices.

The terminal shape or electric voltage may vary according to the power source installed: an in-house wall socket, a power generator, a car battery, or a solar battery. Hence this package equips power inverters to accept multiple types of power source. UPS will contribute to continue the power supply without disconnection when a power source becomes unavailable and then be replaced with another.

### 1.2.2 Class 1: Satellite Package

Satellite links function independently of terrestrial networks. Hence such links are promising to serve even in the situation that the terrestrial networks are damaged seriously. Satellite package provides LLS networks with connectivity to the Internet via satellite as shown in Figure 1.3.

Considering security and service management in the network, the satellite package equips a router, that can handle DHCP, firewall and QoS. Also, expecting that the existing terrestrial network may be recovered, policy-based routing will contribute to optimize the utilization of available bandwidth on both satellite and terrestrial.

### 1.2.3 Class 2: Wi-Fi Package

Wi-Fi package deploys wireless networks in LLS using a satellite-based Internet as its upstream. Expected devices that may connect to this package are smart phones, laptop computers, and

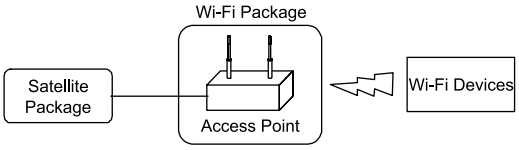



**Fig. 1.4.** Wi-Fi Package

other Wi-Fi enabled devices such as network cameras or sensor nodes.

A typical system component of this package is a Wi-Fi access point to work to provide high-speed network access as shown in Figure 1.4. Mobile nodes may also be included to extend the network coverage using mobile ad-hoc networking technologies.

### 1.2.4 Class 3: Digital Broadcasting Package

Expecting that many victims bring their cellular phone when they evacuate a disaster, LLS installs digital broadcasting transmitter for mobile handheld devices, namely 1 segment broadcasting in Japan. The benefit of using digital broadcasting is efficient dissemination of information to a large number of victims: evacuation area, emergency supply, availability of medication, or safety information for example. Those victims can access such information even if they do not have a device to directly connect the Internet.

Figure 1.5 shows the overview of this package. LLS expects two types of the broadcasting approach, live and archive. Live broadcasting

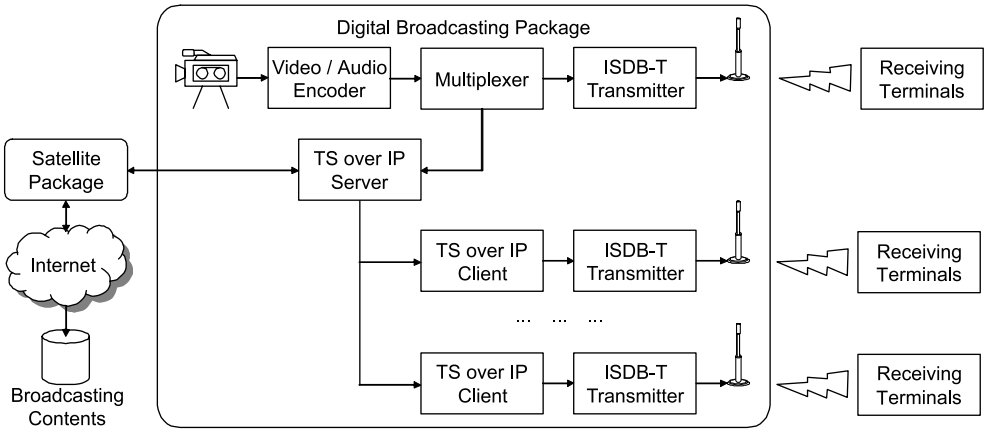



**Fig. 1.5.** Digital Broadcasting Package

enables to broadcast the realtime video and audio to receiving terminals. Meanwhile, archive broadcasting contributes to broadcast contents whose source can be in the upstream Internet or in the LLS networks. The archived contents can also be TV or radio programs, that can be downloaded from the Internet as far as it is already multiplexed to be sent via 1 segment broadcasting systems.

The requirement of digital broadcasting systems in LLS is the capability of handling MPEG-2 TS files or streams over IP communications, so that the source of contents can be either inside or outside LLS network.

#### 1.2.5 Class 4: Wireless MAN Package

Wireless MAN package provides a long-range Internet access in LLS network beyond the coverage of Wi-Fi package. WiMAX is expected as the infrastructure technology. Another aspect of this package is that the long-range connectivity can be the alternative Internet connectivity that can be operated in combination with a satellite link.

#### 1.2.6 Class 5: Advanced Information Services

Advanced information services are the applications that can be achieved by mobilizing sensor devices, robots or vehicles in the LLS network. Remote control of vehicles, telemedicine using vital data, and collection and dissemination of victims' safety or hazardous area will be the typical examples of services in this class.

### 1.3 System Implementation

We developed a prototype of LLS that implements the following packages:

(1) Power Supply Package,
(2) High-speed Satellite Package,
(3) Lightweight Satellite + Wi-Fi Package,
(4) Live Broadcasting Package, and
(5) Archive Broadcasting Package.

The equipment installed in each package is listed in Table 1.2. The chassis of each package is rack-mount housing that is compatible with EIA-310-D. The following sections describes their characteristics and system diagram respectively.

#### 1.3.1 Power Supply Package

The prototype of power supply package is focusing on acquiring electricity from a battery of vehicles, that may be left in a disaster site. As shown in Figure 1.6, this package installs DC 12 V and 24 V power inverters to convert the power supply from a car battery to AC 100 V power for injecting to the UPS.

As long as there is a car battery available in the disaster site, the battery in UPS can be charged to supply stable electricity to devices that support AC 100 V input.

**Table 1.2.** Equipment Installed in LLS

| Power Supply Package | | |
|---|---|---|
| Item | Manufacturer/Supplier | Model |
| DC 12 V Power Inverter | Endo Scientific Instrument | AS1000-12V |
| DC 24 V Power Inverter | Endo Scientific Instrument | AS1000-24V |
| Uninterruptible Power System | OMRON | BN150XR |

| High-speed Satellite Package | | |
|---|---|---|
| Item | Manufacturer/Supplier | Model |
| VSAT Terminal | SKY Perfect JSAT | Satellite Catcher JM-75 |
| Gateway Router | Cisco | Cisco 1812J |
| PoE Injector | BUFFALO | WLE2-POE-S |

| Wi-Fi Package | | |
|---|---|---|
| Item | Manufacturer/Supplier | Model |
| Wi-Fi Access Point | BUFFALO | WLAH-HG-G54/R |
| Wi-Fi Skype Phone | Logitec | LAN-WSPH01WH |

| Lightweight Satellite + Wi-Fi Package | | |
|---|---|---|
| Item | Manufacturer/Supplier | Model |
| INMARSAT Terminal | Thrane & Thrane | Explorer 5000 |
| Gateway Router | Cisco | Cisco 1812J |
| Wi-Fi Access Point | Cisco | AIR-AP1242AG-P-K9 |
| Wi-Fi Skype Phone | Logitec | LAN-WSPH01WH |

| Live Broadcasting Package | | |
|---|---|---|
| Item | Manufacturer/Supplier | Model |
| H.264 Encoder | Envivio | 4Caster |
| Multiplexer | Hitachi Information & Communication Engineering | UM5000 |
| ISDB-T Transmitter | Tektronix | RTX 100A |

| Archive Broadcasting Package | | |
|---|---|---|
| Item | Manufacturer/Supplier | Model |
| ISDB-T Transmitter | ABIT | ACS2000 (Transmitter) |
| Broadcasting Server | ABIT | ACS2000 (Server) |
| PoE Injector | BUFFALO | WLE2-POE-S |

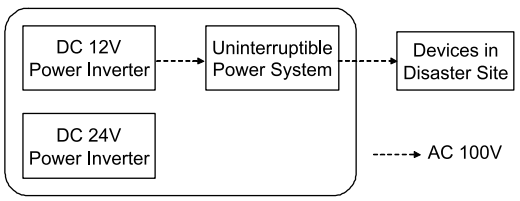



**Fig. 1.6.** Power Supply Package

### 1.3.2 High-speed Satellite Package

High-speed satellite package provides broadband access to the Internet. The system installs a VSAT terminal that can automatically perform antenna pointing using GPS receiver functionality. After assembling the earth station, the pointing procedure will be completed within 5 or 10 minutes without manual installation.

Figure 1.7 shows the system diagram of this package, and Figure 1.8 show the VSAT terminal connected to Power Supply package. This package uses SPACE-IP service that provides 10 Mbps down link to and 2 Mbps up link from the terminal on best effort. This package is expected to work as the primary Internet connectivity. PoE injector in the package is used to accommodate a PoE device, so far that is Wi-Fi package described in the next section.

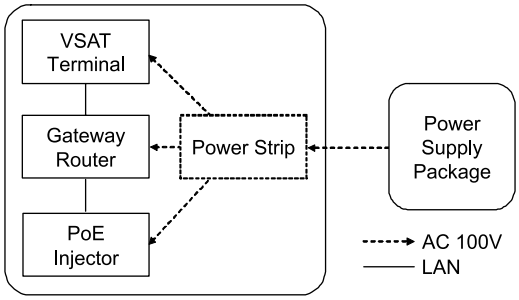



**Fig. 1.7.** High-speed Satellite Package

**Fig. 1.8.** VSAT Terminal

### 1.3.3 Lightweight Satellite + Wi-Fi Package

This package is a combination of a satellite earth station and a Wi-Fi access point to quickly launch a Wi-Fi hot spot in the disaster site. The system diagram of this package is shown in Figure 1.9.

For Internet access via satellite, BGAN service using an INMARSAT terminal is installed to enable 492 kbps connectivity. Figure 1.10 shows the INMARSAT terminal and the Wi-Fi access point that are deployed on the rack mount housing of this package.

The benefit to use this package is that the size of equipment can be small, and the procedure

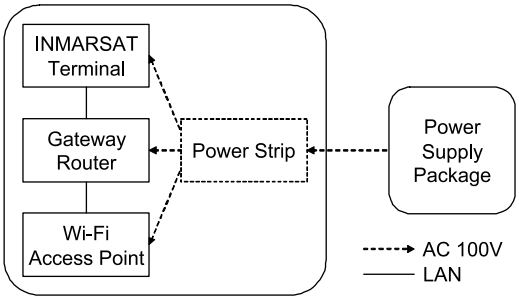



**Fig. 1.9.** Lightweight Satellite + Wi-Fi Package

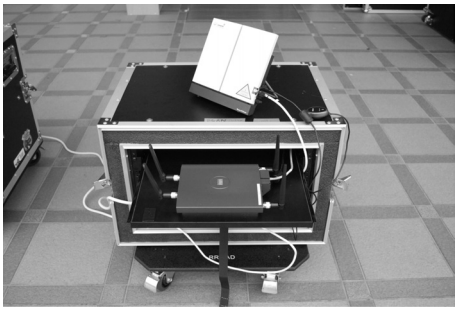


**Fig. 1.10.** INMARSAT Terminal and Wi-Fi Access Point

of antenna pointing is simple compared with the high-speed satellite package. Meanwhile, the available bandwidth of this package is limited, thus the operation will require access control or QoS to optimize utilization of the bandwidth, and prioritize the certain traffic like emergency rescue communication.

### 1.3.4 Live Broadcasting Package

Live broadcasting package is the system to enable live broadcasting for 1 segment receiver terminals such as cellular phones or mobile handheld TVs.

Figure 1.11 shows the system diagram of this package. The video and audio from the live DV camera inputs to H.264 encoder, and then multiplexed as MPEG-2 TS. The ISDB-T transmitter remultiplexes the MPEG-2 TS, and then transmits to the radio frequency with a very small power not to violate the legal conditions in Japan.

Figure 1.12(a) shows the overview of system, and (b) shows a mobile TV terminal and a cellular phone that receives the live contents transmitted by this package. The process of live broadcasting is done in realtime. The delay of video and audio reception is around 5 seconds mainly caused by H.264 encoding and FEC mechanism of the digital broadcasting systems.

### 1.3.5 Archive Broadcasting Package

Archive broadcasting package broadcasts the archived contents that is edited as a completed MPEG-2 TS file preliminarily. Figure 1.13 shows

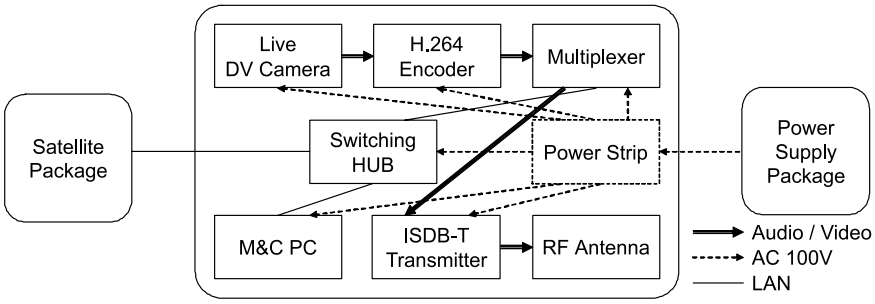
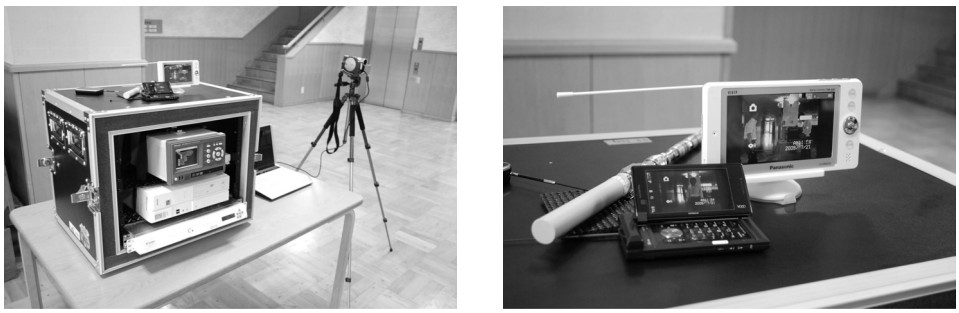



**Fig. 1.11.** System Diagram of Live Broadcasting Package



(a) System Overview (b) Receiver Terminals

**Fig. 1.12.** Prototype System

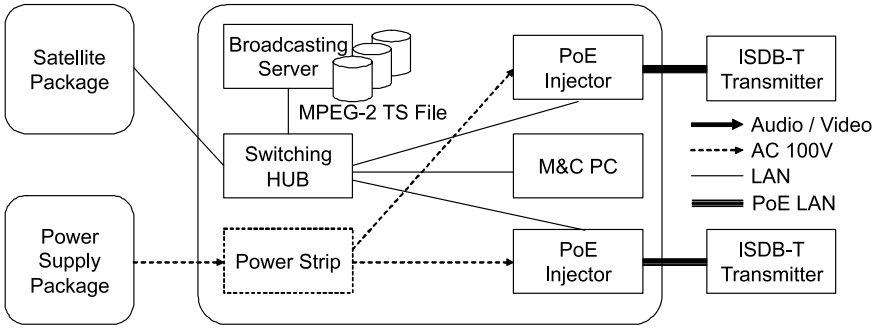



**Fig. 1.13.** System Diagram of Archive Broadcasting Package

(a) System Overview (b) Transmitter and Cellular Phone

**Fig. 1.14.** Prototype System

the system diagram of this package. The file is downloaded from the Internet, and then kept in the broadcasting server. Based on the command from M&C PC, the broadcasting server sends the MPEG-2 TS to ISDB-T transmitter using unicast or multicast.

This approach indicates that once the digital data of source material can be transferred from the disaster site to the outside, the task of editing broadcasting contents can be outsourced to volunteers that are outside the disaster site through the Internet.

### 1.4 Demonstrations of the Prototype

The prototype of LLS has been tested in Kurihara city of Miyagi prefecture in 2009. That city has been conducting collaborative activities with Keio University since January of 2008, and hit by a serious earthquake in June of that year.

The first trial was held to introduce the concept of LLS, and to perform the demonstration of the prototype in March of 2009. This trial revealed that the installation procedure of LLS can be completed within 5 minutes when using high-speed satellite package and Wi-Fi package including power supply from a car battery. A laptop computer and a Wi-Fi phone device were connected to the LLS network to enable video conferencing and telephony service through the Internet. The trial also showed that digital broadcasting package functions well to enable dissemination of information to victims. The archived contents, which were originally edited by the authors, were broadcasted to cellular phones in a tightly limited range with about 50 cm diameters.

Another trial was held in July of 2009. This trial included a workshop for getting feedback from the potential users of LLS. In this trial, the office staffs of Kurihara city hall installed and launched LLS under the instruction of the authors. And then, the workshop was held for (1) sharing experience in the actual disaster situation of the earthquake in 2008, and (2) discussing issues raised from the LLS field trial.

### 1.5 Summary

As the early-phase activities of LLS WG, we focused on concept building and prototyping of LifeLine Station. The concept of this system is built considering the situation of disaster site hit by a big earthquake, where existing power supply or communication infrastructure can be damaged. The six classified packages are designed to be easily handled and operated accordingly with the actual situation of the disaster site. The prototype of LLS has been tested in Kurihara city since March of 2009.